

# DETECTION AND DETERRENCE OF COUNTERFEITING OF DOCUMENTS WITH A SEAL HAVING CHARACTERISTIC COLOR, SIZE, SHAPE AND RADIAL DENSITY PROFILE

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

The present invention relates to printing and, more particularly, to the prevention of printing of counterfeit currency or other documents.

### 2. Description of the Related Art

Modern technology has made it easy for most people to quickly and inexpensively make accurate color copies of documents. This copying can be achieved through the use of a color copier or by scanning the document and then printing it using a color printer. There are many legitimate uses for this copying technology, however a small percentage of people use color copying to make counterfeit currency or to counterfeit other documents.

One way to prevent counterfeiting is to use techniques such as are taught by Sato, "Color image input apparatus having color image identifying function", U.S. Pat. No. 5,638,496, issued, Jun, 10, 1997. Sato describes a line sensor and image input section that input a color image in a reading area containing an original, an original extracting section that extracts an area of the original from the input image, a normalization section that normalizes an image of the extracted original area to an image of preset size, an image averaging section that converts the normalized image into an averaged image, and a brightness-hue-chroma converting section that converts the averaged image in Vcd images used as color perception amounts of a human being. A pattern matching section collates the Vcd image with dictionary data in a dictionary data storing section to determine whether or not the original is a specified type of original such as a bill, and an image output controlling section then determines whether or not image data output from the color image input section is to be output to the exterior based on the result of the identification.

Thus typical techniques such as searching for a particular pattern or color distribution can be used to detect and stop the copying of a counterfeit document. However, these techniques can be computationally intense and therefore place an undesirable delay on the copying of every document. This delay is particularly undesirable when one realizes that the majority of documents copied are made, not by counterfeiters, but by law-abiding citizens who are copying documents for legitimate purposes.

Thus, it can be seen that current counterfeiting detection and deterrence techniques impose processing delays upon color copying devices, and hinder the use of these devices in many applications.

Therefore, there is an unresolved need for a counterfeiting detection and deterrence technique that permits one to make color copies without imposing processing delays upon color copying devices.

## SUMMARY OF THE INVENTION

A method and apparatus is described for detection and deterrence of counterfeiting that permits one to make legitimate color copies without introducing visual artifacts or experiencing substantial processing delays.

An efficient counterfeit deterrence is enabled by the use of an hierarchic detection scheme, in which the majority of

documents are classified as free of suspicion using a simple characteristic color detection algorithm that imposes a negligible computational burden. The remainder of documents, which are labeled as suspicious, receive analysis by a block-based morphologic detection algorithm and then possibly other additional detection algorithms. If the suspicious document is identified as being a secure document, this will lead to printing with selectively deteriorated service or complete denial of service.

For one embodiment, a seal having characteristic color, size, shape and radial density profile is incorporated into the design of frequently counterfeited documents. In the case of US currency, the already present "treasury green" treasury seal can serve as a suitable seal. The document is partitioned into appropriately sized blocks. A block is labeled suspicious if it contains the characteristic color. The scheme uses a color look-up table (LUT) to detect an initial block with a pixel having the characteristic color. A block-based morphologic detection algorithm then uses dilation to group neighboring suspicious blocks into suspicious regions. One can then examine size, shape, density, and color density profile to check each suspicious region, and to thereby verify that printing of a counterfeit is being attempted. Conventional tests for counterfeit documents can also be used as a further, higher level test.

The invention is robust, has negligible impact on the time to render a page and negligible effect on general images and documents, while denying printing or generating visible artifacts on banknote or other secure document images. The scheme can be deployed in a printer driver with no hardware changes and can be adjusted to arrive at a compromise that allows reasonable detection, while causing minimal effect on legitimate users. Furthermore, this method can provide a visible indicator that currency is not counterfeit. Moreover, so long as the seal does not change, no alteration is required for a new series of notes.

## BRIEF DESCRIPTION OF THE DRAWINGS

The invention will be readily understood by the following detailed description in conjunction with the accompanying drawings, wherein like reference numerals designate like structural elements, and in which:

FIG. 1 is a diagram illustrating a color copying system suitable for use with a counterfeiting detection and deterrence scheme according to the present invention;

FIG. 2 is a diagram illustrating detection process flow according to an embodiment of the present invention;

FIG. 3 is a diagram illustrating currency having a seal suitable for use with a counterfeiting detection and deterrence scheme according to the present invention;

FIG. 4 is a diagram illustrating an initial step for block-based morphological search and detection according to an embodiment of the present invention;

FIG. 5 is a diagram illustrating a subsequent step for block-based morphological search and detection according to an embodiment of the present invention;

FIG. 6 is a diagram illustrating a characteristic color radial density profile according to an embodiment of the present invention; and

FIG. 7 is a diagram illustrating the detection process according to an embodiment of the present invention.

## DETAILED DESCRIPTION OF THE INVENTION

Embodiments of the invention are discussed below with reference to FIGS. 1-7. Those skilled in the art will readily